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NOAA-TM-NMFS-SWFC-135

U.S. DEPARTMENT OF COMMERCE
National Oceanic & Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Center

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ABSTRACT

Research on the Laysan Island population of the endangered Hawaiian monk seal, *Monachus schauinslandi*, was conducted from 2 March to 30 November 1985. Census totals excluding pups ranged from 76 to 147 ($\bar{x}$ = 101.6), an average increase of nearly 20 animals from the 1984 census results. Overall monthly haul-out distribution for all seals showed highest use in the north ecological unit followed by the west unit. Relatively few animals hauled out in the eastern and southern portions of the island. Interatoll movement of nine seals was documented, resulting in a net increase of three animals to the Laysan Island population.

CONTENTS

INTRODUCTION

Laysan Island, located within the Hawaiian Islands National Wildlife Refuge at lat. 25°42'N, long. 171°44'W (Fig. 1), is one of the major breeding, pupping, and haul-out sites of the endangered Hawaiian monk seal, *Monachus schauinslandi*. Intensive research to monitor the monk seal population and to identify factors contributing to its decline on Laysan Island was initiated in 1977 and has continued on a yearly basis, e.g., Johnson and Johnson (1978, 1981a, 1981b, 1984) for 1977-80, Knudtson[1] for 1981, Alcorn (1984) for 1982, Alcorn and Buelna (1989) for 1983, and Johanos et al. (1987) for 1984. Detailed information, including past research efforts, on the history, geology, flora, and fauna of Laysan Island is presented by Ely and Clapp (1973).

The primary objectives of this paper are to report the census summaries, including haul-out distribution, and data on interatoll movement during a 9-month-long field camp established on Laysan Island from 2 March to 30 November 1985 by the Southwest Fisheries Center Honolulu Laboratory of the National Marine Fisheries Service (NMFS), NOAA. Johanos and Austin (1988) present the 1985 findings on the structure, reproduction, and survival of the monk seal population at Laysan Island. Results on the webbing (entanglement debris) inventories at Laysan Island in 1985 are summarized in Henderson et al.[2]. Other 1985 studies conducted concurrently by NMFS researchers on male seal aggressive behavior, diet of the seals, and green turtle tagging and sightings will be reported elsewhere.

METHODS

A two-person team conducted censuses every third day, on the average, at Laysan Island from 6 March through 26 November 1985. Census data collection was rotated among field personnel until 22 July when only two members of the field party remained (see Appendix A). Each census commenced at approximately 1300 (Hawaii standard time), requiring 1.42-4.67 hours ($\bar{x}$ = 2.55 hours) to complete.

The census-patrol form used in recording census, patrol, and incidental data is included in Alcorn and Buelna (1989), and the 1985 revised census-patrol form coding instructions are included in Appendix B. Methods for a two-person census and criteria used for counting seals are delineated in Johanos et al. (1987).

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[1]Knudtson, E. P. Hawaiian monk seal observations at Laysan Island, March-July 1981. Unpubl. manuscr., 23 p. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

[2]Henderson, J. R., S. L. Austin, and M. B. Pillos. 1987. Summary of webbing and net fragments found on Northwestern Hawaiian Islands beaches, 1982-86. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep. H-87-11, 15 p.

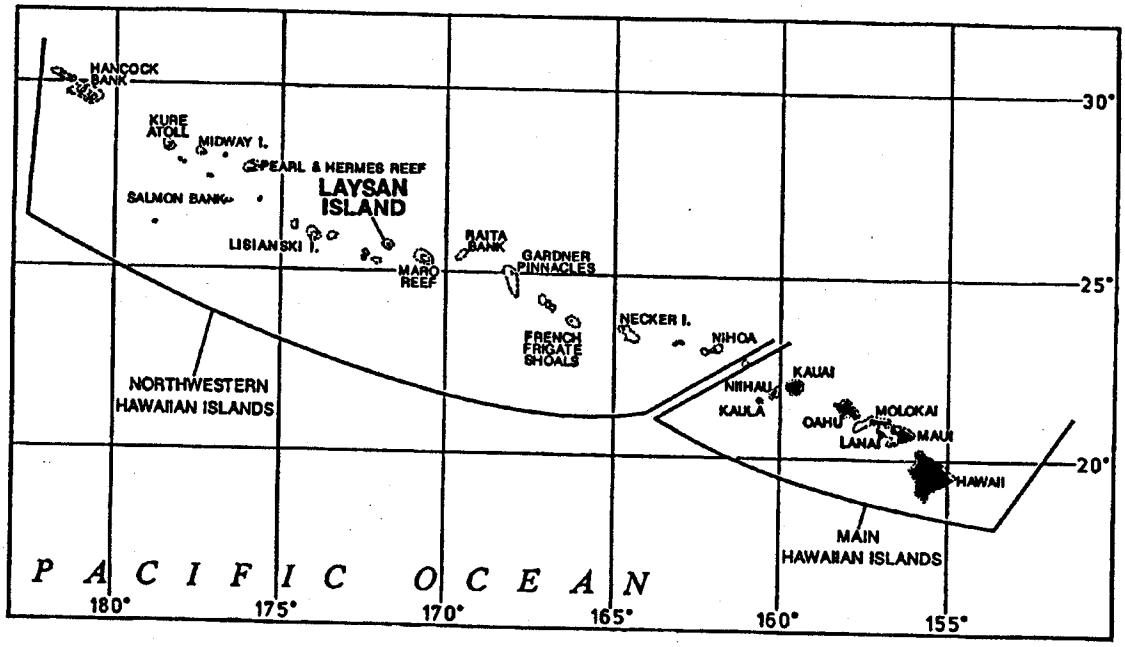

Figure 1.--Location of Laysan Island, Northwestern Hawaiian Islands.

Methods used for sex and age (size) classification and individual seal identification during censusing are detailed in Stone (1984). Standardization of sex identification and size classification during data analysis between known and unknown animals is presented in Johanos et al. (1987). The ability to individually identify specific animals varied during the field season. Many adult males and a few other late molting seals were unbleached at the onset of the 1985 field season because of the timing of the 1984 Laysan Island field camps, which were from 29 March to 7 August and 22 October to 6 November. Therefore, initial efforts of the 1985 season concentrated on bleach marking these adult males, resulting in more individually identified seals as the season progressed. Rebleaching animals postmolt in 1985 was restricted to adult and subadult males, thus limiting individual identification of other postmolt animals to those with tags or distinctive natural marks (light pelage spots or scars). There was a slight potential that sizing of an unidentified animal was not accurate because of variation among observers and even between census counts by the same observer. This discrepancy was corrected during data analysis for identified animals. Without a seal's known identification, an observed animal may not be accurately sexed or sized. Therefore, information on the sex and size composition of the beach count data was not as complete for the beginning and later portions of the field season.

To evaluate seal haul-out distribution patterns, the four ecological units defined by Johnson and Johnson (1978) were utilized. The map showing the 20 sectors on the perimeter of Laysan Island is presented in Figure 2. Ecological unit north (characterized by wide beaches that are exposed to trade winds, with little or no vegetation at the beach crest) corresponds to sectors 3-8; east (having wide beaches, with a shallow rock ledge extending the length of the nearshore area and no vegetation near the beach crest) to sectors 9-13; south (having sand beaches interspersed with rock ledges, rough surf, and

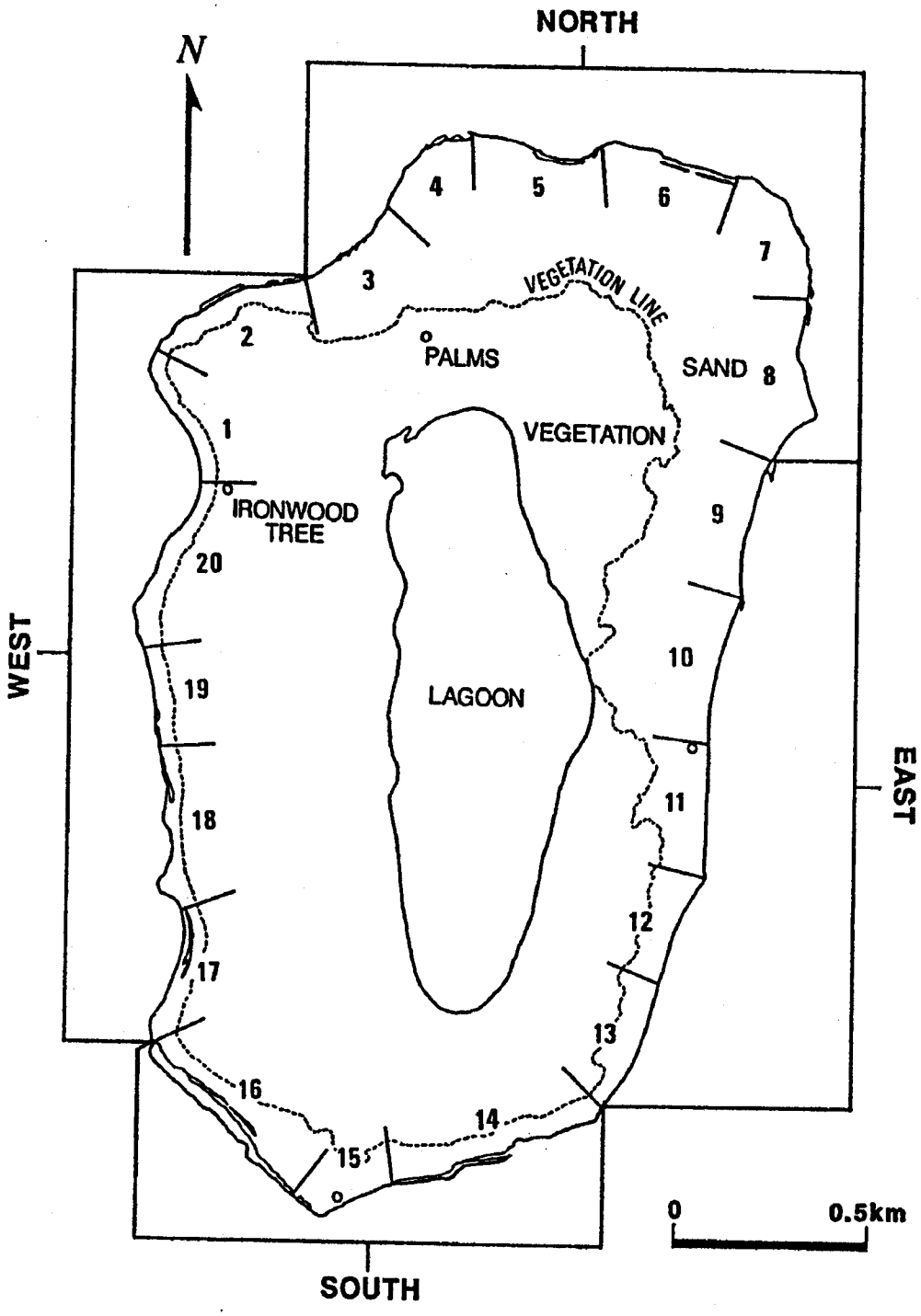

Figure 2.--Map of Laysan Island showing 20 sectors and the corresponding ecological units--north, east, south, and west, 1985.

some cover at the beach crest) to sectors 14-16; and west (having narrow beaches, on the leeward side of the island, with numerous shallow reef areas in the nearshore waters, and vegetation at the beach crest) to sectors 1, 2, and 17-20. It should be noted that these 20 sectors differ in size from those utilized in the 1977-81 studies (Alcorn 1984). In 1982, the sector boundaries were redefined to divide the island into 20 approximately equal sections for subsequent data collection.

Documentation of interatoll movement by seals in 1985 was limited by the duration of the other NMFS field camps (French Frigate Shoals, 4 April to 11 September; Kure Atoll, 29 January to 23 October; Lisianski Island, 17 June to 20 July; and Pearl and Hermes Reef, 18 June to 17 July) and the frequency of seal surveys at each location. Also, as previously mentioned, not all of the animals present on Laysan Island in 1984 or in 1985 were rebleached postmolt, and none of the seals from the other islands was bleach marked postmolt in 1984, although animals were bleach marked on Kure Atoll in 1985. Uniquely numbered plastic Temple Tags,[3] color coded by island, were applied to the hind flippers of weaned pups on most islands during the 1985 and previous field seasons, and a few adult animals had Monel metal tags applied to their hind flippers. Therefore, monitoring of interatoll movement was limited to sightings of bleach marked individuals from Laysan Island and Kure Atoll and animals with tags or distinctive natural markings.

RESULTS AND DISCUSSION

Census

The total number of seals observed during each of the 86 censuses conducted during the 9-month research period ranged from 93 to 166 ($\bar{x}$ = 117.6) and, excluding pups of the year, ranged from 76 to 147 ($\bar{x}$ = 101.6) (Appendix C). Censuses conducted on Laysan Island from 7 May to 3 August 1984 had counts ranging from 81 to 120 ($\bar{x}$ = 99) (Johanos et al. 1987), compared with 1985 counts of 99 to 138 seals ($\bar{x}$ = 118.5) during the corresponding time period. Excluding pups of the year, the 1984 counts ranged from 64 to 101 seals ($\bar{x}$ = 82) (Johanos et al. 1987), compared with corresponding 1985 counts of 83 to 120 animals ($\bar{x}$ = 99.1).

There was an increase of nearly 20 animals between average counts of 1984 and 1985, both including and excluding pups. This is partially accounted for by the net increase of 25 identified individuals (Johanos and Austin 1988), excluding pups, documented from the 1984 to 1985 field seasons. The 1984 census data were collected every other day during the 3-month period and had a total of 45 censuses (Johanos et al. 1987), whereas 1985 census data were collected every third day and had a total of 31 censuses during the corresponding period. The 1985 censuses commenced an hour later than the 1984 censuses

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[3] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

(Johanos et al. 1987). However, neither of these differences in census data collection methods between years would contribute to a significant difference in the number of observed seals.

Also, the 1985 research efforts were more intensive, having a maximum of four observers compared with three in 1984 (Johanos et al. 1987). The amount of island coverage increased dramatically, and intensive behavior studies were also initiated in 1985 (Johanos and Austin 1988). The level of disturbance was potentially greater with the increase in human activities, yet the 1985 counts revealed a population increase. These results show no obvious correlation between number of researchers and study effort adversely affecting the census counts. A summary of 1985 seal census data, by size and sex, and the monthly means are presented in Appendix C. The monthly means of the nonpup census totals ranged from 92.8 animals in August to 113.3 animals in March. The largest difference in consecutive monthly mean counts was between March and April, when 16 fewer animals were seen.

The size and sex composition of animals censused fluctuated monthly during the research period. Seals were sexed in 88% of 8,739 nonpup census sightings. The highest counts for each group occurred during the molting period, except for adult females who had the highest counts in May during the pupping and nursing period. The mean monthly number of adult males, the largest group of animals observed per census, had the lowest counts in July, averaging 23.4 animals, and peaked in September with 59.8 seals, nearly tripling the lowest count. The mean counts of adult females, comprising the second largest group present, ranged from 7.8 animals in September to 22.3 in May, again almost tripling the low. Both the subadults and juveniles comprised relatively small, equal portions of the animals counted. The mean number of subadult males more than doubled from a low of 5.2 animals in October to 12.1 in July. The most pronounced fluctuation between mean monthly counts was in the subadult females, ranging from 1.9 animals in September to 12.8 in both May and June. The juvenile male and female mean counts showed little monthly variation. It should be noted that the actual sex composition of the animals may differ slightly from that of the animals censused because not all seals were sexed.

Haul-Out Distribution

For all seals observed, the overall mean monthly haul-out distribution pattern showed highest use in the north unit, followed by the west unit, with relatively few animals hauling out in the eastern and southern portions of the island (Fig. 3A). This pattern was consistent with previous findings by Johnson and Johnson (1978, 1984), but the proportion of total animals utilizing each unit varied from the 1977 and 1980 results. The 1985 counts indicated an increased preference for the northern area over the western area.

Further examination of haul-out distribution by size and sex revealed that the juveniles, subadults, and adult females closely followed the general haul-out pattern previously described (Fig. 3B-D), yet the adult males deviated markedly in their shoreline utilization (Fig. 3E). Comparable information on haul-out by size and sex is not available in Johnson and Johnson (1978, 1984). Unlike the other seals, the adult males did not exhibit a greater preference for areas in the north over the west, yet a higher percentage of the

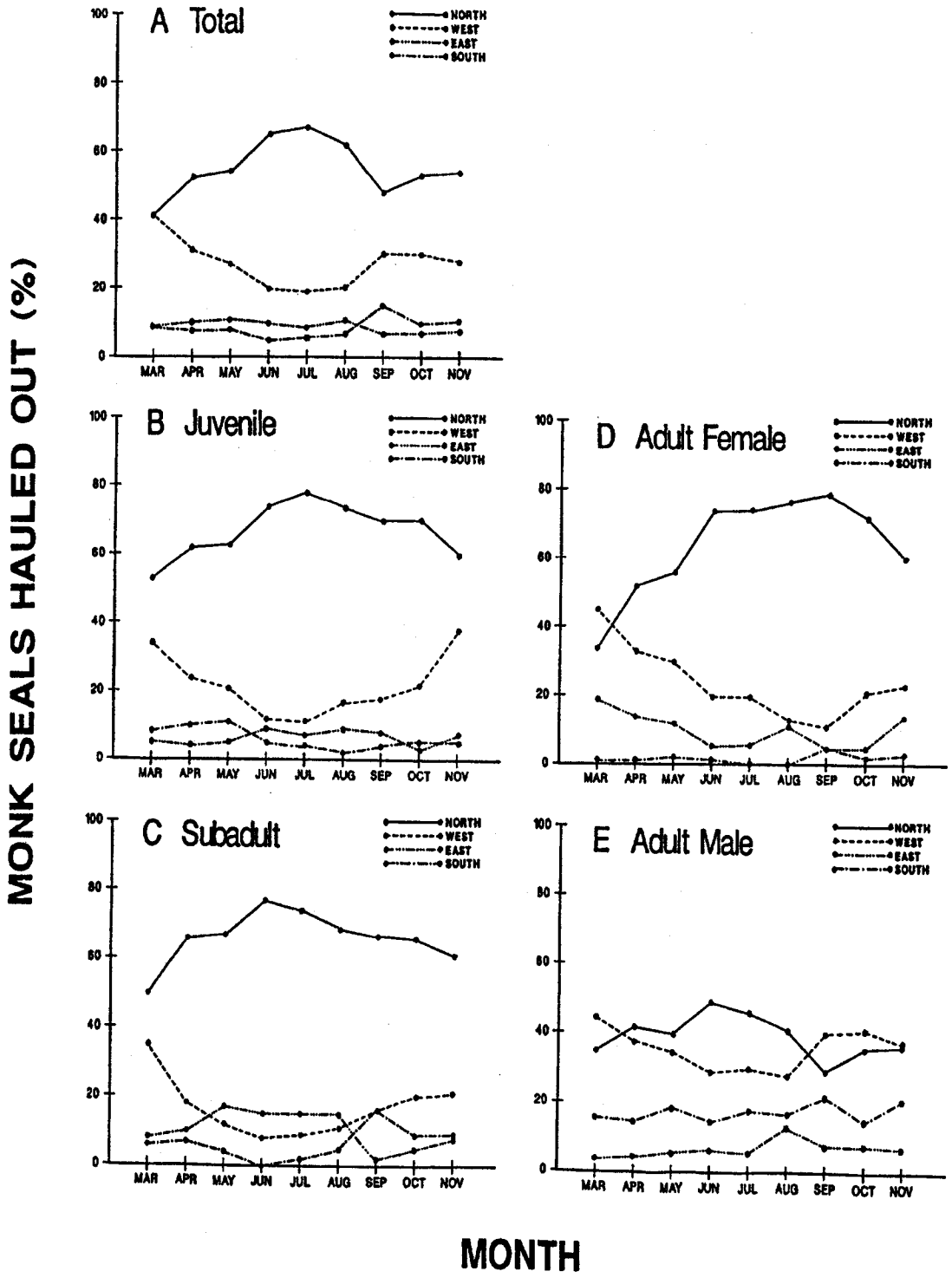

Figure 3.--The mean monthly percentage of seals ashore in each of the four ecological units on Laysan Island, 1985: (A) total seals (including pups), (B) juveniles (includes both sexes), (C) subadults (includes both sexes), (D) adult females, and (E) adult males.

adult males hauled out on the south shore. It should be noted that the haul-out distribution results for adult males and adult females may be slightly off because not all animals were sexed during the censuses. Factors affecting this shift in haul-out distribution are described in Johnson and Johnson (1978, 1984).

Interatoll Movement

Observations during the 1984 and 1985 field seasons revealed known interatoll movement of nine seals (six females and three males) between Laysan Island, Lisianski Island, and French Frigate Shoals (see Table 1). Six of these animals (TA34, G055, GA59, T08F, T25F, and Y156) have a past history of interatoll movement. None of the nine adult males relocated from Laysan Island to Johnston Atoll in November 1984 (Gilmartin[4]) was resighted on Laysan Island in 1985.

Since the 1984 field season, two incidents of round-trip travel between Laysan Island and another island were documented. Tagged 2-year-old male G065, born on Lisianski Island, was observed there in 1984, traveled to Laysan Island where he was sighted only once on 2 June 1985, and then returned to Lisianski Island later in 1985 (Alcorn et al. 1988). In 1984, adult female Y156 was bleach marked on Laysan Island (Johanos et al. 1987), emigrated to French Frigate Shoals where she pupped prior to 8 April 1985 (Eliason and Webber[5]), and then returned after weaning to Laysan Island where she molted and possibly mated in 1985. Interestingly, Y156 followed the same round-trip pattern in 1984, including pupping at French Frigate Shoals (Johanos et al. 1987; Eliason[6]).

Four animals--adult females T08F, T25F, and GS86 and 2-year-old Laysan male TA34, last observed on Lisianski Island in 1984 (Alcorn et al. 1988)-- immigrated to Laysan Island in 1985. Both T08F and T25F pupped on Laysan Island in 1985. Female T25F had previously pupped on Lisianski Island in 1984 (Alcorn et al. 1988). Two female seals--2-year-old G055, born on Lisianski Island, and adult GA59, both last observed on Laysan Island in 1984 (Johanos et al. 1987)--immigrated to Lisianski Island in 1985 (Alcorn et al. 1988). Two-year-old male TA10, who was born on Laysan Island and was last seen

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[4]Gilmartin, W. G. Translocation of adult male seals from Laysan Island to Johnston Atoll. Manuscr. in prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

[5]Eliason, J. J., and M. A. Webber. French Frigate Shoals monk seals: 1985. Manuscr. in prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

[6]Eliason, J. J. Hawaiian monk seal observations at French Frigate Shoals, 1984. Manuscr. in prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

Table 1.-- Observed interatoll movement of Hawaiian monk seals to and from Laysan Island during 1985 (A = adult, S = subadult, J = juvenile, M = male, F = female, FFS = French Frigate Shoals).[a]

ID	Tag No. Left	Tag No. Right	Tag No. (color)	Size	Sex	Emigration from Location	Emigration from Date last seen	Immigration to Location	Immigration to Date first seen	Comments
TA10	--	--		J	M	Laysan	5/27/83	FFS	7/8/85	Not sighted on any islands in 1984.
TA34	A34	A33	(tan)	J	M	Lisianski	8/4/84	Laysan	4/19/85	Laysan 1983 pup.
G065	A65	A66	(green)	S	M	Lisianski Laysan	7/27/84 6/2/85	Laysan Lisianski	6/2/85 6/21/85	Lisianski 1983 pup. Only one sighting on Laysan.
G055	A55	A56	(green)	S	F	Laysan	8/6/84	Lisianski	6/19/85	Lisianski 1983 pup.
GA59	--	--		A	F	Laysan	4/2/84	Lisianski	7/15/85	
GS86	--	--		A	F	Lisianski	7/5/84	Laysan	3/25/85	Molted on Laysan in 1985.
T08F[b]	--	--		A	F	Lisianski	8/1/84	Laysan	3/8/85	Pupped prior to 3/8/85 on Laysan.
T25F[c]	--	--		A	F	Lisianski	7/9/84	Laysan	6/18/85	Pupped 6/24/85 on Laysan.
Y156	--	--		A	F	Laysan FFS	11/2/84 5/13/85	FFS Laysan	4/8/85 5/31/85	Pupped prior to 4/8/85 on FFS, molted on Laysan in 1985.

[a]The data are from the following sources: Laysan 1983 (Alcorn and Buelna 1989), 1984 (Johanos et al. 1987), and 1985 (Johanos and Austin 1988); Lisianski 1984, 1985 (Alcorn et al. 1988); FFS 1985 (text footnote 5).

[b]Laysan Island seal T08F was bleached A83 on Lisianski Island in 1982; therefore, 08F in the 1982 Laysan Island report (Alcorn 1984) is the same seal as A83 in the 1982 Lisianski Island report (Stone 1984).

[c]Laysan Island seal T25F was bleached 165 on Lisianski Island in 1982; therefore, 25F in the 1982 Laysan Island report (Alcorn 1984) is the same seal as 165 in the 1982 Lisianski report (Stone 1984).

there in May 1983, immigrated to French Frigate Shoals in 1985. This animal was not sighted at any location in 1984.

Of the three parturient adult females that were sighted on Laysan Island and had moved among the islands in 1985, two (T08F and T25F) gave birth on Laysan Island and one (Y156) on French Frigate Shoals. Taking their three pups into account, the known net result of interatoll movement during the 1985 research period is an increase in the Laysan Island population by three animals (including one pup). Not only can interatoll movement affect the annual population size of an island, but it also potentially affects the genetic composition of that population.

Three other animals (T39F, GS33, and TT12) sighted on Laysan Island in 1985 also may have moved. Identifiable by distinctive natural markings, though unbleached, adult female T39F was first sighted in 1985 on Laysan Island on 11 July, just 4 days before the birth of her pup and 3 months after research had begun. This long absence (a minimum of 3 months from Laysan Island) may reflect movement between islands. It is interesting to note that T39F followed a similar pattern in 1984, appearing 3.5 months after research began and immediately prior to pupping (Johanos et al. 1987).

Bleached subadult male GS33 was observed regularly on Laysan Island for 1-2 days the first of every month from 11 March until 9 May 1985, then was not resighted on Laysan Island until 7 July. Green algae was present in its pelage at the 7 July sighting, indicating a long period at sea. With a past history of being sighted at French Frigate Shoals (Fairaizl[7]) and Lisianski Island (Stone 1984), GS33 may have traveled between islands during his 2-month absence from Laysan Island. His bleach mark was faint, thereby decreasing the chances of identification at other islands.

The third possible interatoll animal, tagged female TT12, was last seen 6 July on Laysan Island during the 1984 field season, which ended on 7 August. At this last sighting, TT12 was at least 98 days old, having weaned prior to the onset of research in 1984. This female was not resighted as a 1-year-old until 25 May 1985 on Laysan Island (3 months after research began). Then another 3-month absence occurred before she was resighted on 20 August. Her last 1985 sighting on 12 September was 2.5 months before research ended on Laysan Island. Again, these long absences may indicate interatoll movement.

Of the 184 identifiable animals from the 1984 field season, 12 were not resighted during 1985 research efforts (Johanos and Austin 1988). It is unknown how many of these 12 animals emigrated or died, but one of these animals, having a past history of interatoll transit, may have emigrated from Laysan Island. Adult female G130 was originally bleached on Lisianski Island in 1983 (Johanos and Kam 1986) and then immigrated in 1984 to Laysan Island (Johanos et al. 1987) where she was rebleached postmolt. She was

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[7]G. W. Fairaizl, Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, Honolulu, HI 96822-2396, pers. commun., November 1983.

not resighted in 1985, but the short-term field camps on the other islands may not have coincided with her time ashore.

The 1985 results indicate the Laysan Island population is increasing, with the haul-out distribution patterns remaining consistent with previous findings. The average increase in the population (20 animals) from census counts is twice the number of animals that had moved interatoll. Clearly, immigration and emigration alone cannot explain the increase in population. Maintaining individual identities for each animal in future research will elucidate the specific factors affecting the population's size and offer clues in determining appropriate management strategies to further increase the population.

ACKNOWLEDGMENTS

We acknowledge and thank Susan L. Austin, John R. Henderson, Thea C. Johanos, Miriam B. Pillos, and Rodney T. Watson for their assistance with data collection. We also acknowledge the support of the Hawaiian Islands National Wildlife Refuge staff of the U.S. Fish and Wildlife Service for maintaining radio communications and other cooperative efforts. We thank Capt. Ed Shallenberger and crew of the *Feresa*, and the captains and crew members of the NOAA ship *Townsend Cromwell* for transporting personnel and supplies to and from Laysan Island throughout the field season. We also extend our thanks to the flight crews of the U.S. Coast Guard, Barbers Point, for airdropping supplies to Laysan Island.

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APPENDIXES

Appendix A.--Itinerary of census fieldwork conducted on Laysan Island in 1985 by the National Marine Fisheries Service.

Date	Event
3/2	NOAA ship *Townsend Cromwell* arrives at Laysan Island.
3/3	*Townsend Cromwell* disembarks S. Austin, B. Becker, J. Henderson, R. Watson, and two cooperating U.S. Fish and Wildlife Service (USFWS) scientists at Laysan Island and departs for Honolulu. Field camp is established.
3/6	Census data collection begins.
4/1	The fishing vessel *Feresa* arrives at Laysan Island and disembarks T. Johanos and three cooperating USFWS scientists.
4/9	*Feresa* embarks Henderson and four cooperating USFWS scientists and departs for Honolulu.
6/16	*Townsend Cromwell* arrives, embarks Johanos and Watson, disembarks M. Pillos, and departs for Lisianski Island. *Feresa* arrives and disembarks two cooperating USFWS scientists.
7/21	*Townsend Cromwell* arrives; embarks Austin, Pillos, and three cooperating USFWS scientists; disembarks R. Morrow; and departs for Honolulu.
8/15	*Townsend Cromwell* arrives and disembarks J. Leialoha.
8/19	*Townsend Cromwell* embarks Becker and departs for Gardner Pinnacles.
11/26	Census data collection ends.
11/30	The Laysan Island field camp is disbanded. *Townsend Cromwell* arrives, embarks Leialoha and Morrow, and departs for French Frigate Shoals.

Appendix B.--The Hawaiian monk seal and green turtle census-patrol form coding instructions, 1985.

OBSERVER--Three initials

TIME BEGIN and END--On a 24-h clock, e.g., 6 p.m. = 1800, for the group of pages

DATA TYPE--C = Census = a complete count on an island begun around 1300
A = Atoll-wide census (usually completed during 1 d)
P = Patrol = any other observation not on a timed census
Other letters may be used at your discretion to indicate specific kinds of noncensus data, e.g., M for male observations.

PAGE--If census (or patrol) requires three pages, then mark first page as"page 1 of 3" and so on. If two people census with separate sheets, then combine page numbers; person A has pages 1 and 2, while person B has pages 3 and 4 of a four-page census day.

TEMP.--Temperature in degrees Celsius at beginning of census or patrol

WIND-- Speed: 0 = no wind, calm (< 5 knots)
1 = light breeze (5-15 knots)
2 = strong wind (> 15 knots)
Thus, 2NN = strong wind from north

Direction: NW, NN, NE, EE, SW, SS, SE, WW

CLOUD--Cloud cover: 00 = no clouds
01-09 = 10 to 90% cover
10 = 100% cover

PREC.--Precipitation: 0 = no precipitation
1 = mist/drizzle
2 = rain
3 = intermittent rain

SECTOR--Location on island (e.g., 1-49 on Lisianski; 99 = no island)

SIZE--P1 = Nursing pup, wrinkles
P2 = Nursing pup, no wrinkles
P3 = Nursing pup, blimp, black
P4 = Nursing pup, molting
P5 = Nursing pup, molted

P = Nursing pup

Appendix B.--Continued.

PW = Prematurely weaned (undersized) pup
W = Weaned pup
J1 = Juvenile I } J = Juvenile
J2 = Juvenile II
S3 = Subadult III } S = Subadult
S4 = Subadult IV
A = Adult
T1 = Turtle, juvenile (< 65 cm) } T = Turtle
T2 = Turtle, subadult (65 - 80 cm)
T3 = Turtle, adult (> 80 cm)
U = Seal of unknown size

I = Immature

SEX--M = Male
F = Female
U = Unknown

ID--Record ID number of seal if known; right justified: seal #25 = _25

? column: ✓ or 1 = ID number is questionable
0 = seal is definitely not an IDed animal

BLEACH--Bleach number of seal if known; right justified; these columns may also be used for any temporary numbers assigned in the field

? column: ✓ or 1 = bleach is present, but the number is questionable
0 = seal is definitely unmarked

TAG--Tag number if known; right justified: tag #K23 = _K23

L/R: Tag position L = tag on left flipper
R = tag on right flipper
B = tags on both flippers
(only one tag number need be entered)

COL: Color code T = tan (Laysan)
K = gray (Kure)
Y = yellow (FFS)
M = metal
G = green (Lisianski)
R = red (Midway, Necker, Nihoa)
B = blue (Pearl and Hermes)

? column: ✓ or 1 = seal is tagged, but the number is questionable
0 = seal is definitely not tagged

BEACH POS.--Location of seal or turtle when observer comes abreast of animal (e.g., if seal is seen midbeach from a distance and yet is at the waterline when the observer comes abreast, the seal is recorded as being at the waterline).

Appendix B.--Continued.

0 = animal floating in water or on an offshore rock (not included in census tally but may be used for behavioral data)
1 = along waterline, on wet sand
2 = midbeach, on dry sand
3 = vegetation zone or beach crest, on permanent beach

MOLT--Percentage of old pelage lost, optional for nursing pups

blank or 0	=	no molting evident
_1-_99	=	1 to 99% molted (right justified)
100	=	100% molted, freshly molted, up to 1 mo after molt

? column: ✓ or 1 = % molt estimate is questionable, but is molting

DISTURB--The degree to which the seal may have been disturbed by observer

blank or 0	=	no disturbance, or seal merely looked at observer
1	=	seal vocalized, gestured, or moved $\leq$2 body lengths
2	=	seal alerted to observer and moved >2 body lengths
3	=	seal alerted to observer and fled into water

TIME--The time of an observation, on a 24-h clock, optional

ASSOCIATION DATA--There is room to describe two different associations (A and B).

Active associations
1) noted for all except behaviors between mother and nursing pup
2) must take place within 30 m of observer
3) subjects may be any distance apart

Spatial associations
1) noted as observer comes abreast of the subject
2) entangling object: distances <2 m away
3) individual seals and turtles
- mother-pup pair (N): any distance
- all others (L): distances $\leq$ 10 m away, record two nearest neighbors in straight line of sight
- record seal-seal and turtle-seal but not turtle-turtle associations

LINE NO.--Identity of the other party in the association

1) if a seal or turtle, put its line number here
(note line number refers to within same census page only)

Appendix B.--Continued.

2) if an entangling object, put
NR or 99 = net and/or rope
FL or 98 = flotsam other than above

DIST.--Closest distance during behavior

0 = body contact
1 = <2 m
2 = 2-5 m
3 = >5 m (>5 m but ≤10 m in the case of **L** behavior code)

BEHAVIOR--Up to four behaviors may be recorded for each association, but **N, E,** and **O** should not appear together with other behaviors

1) individual seal or turtle
a) active behavior

A = approach/investigate/sniff/nudge		
B1 = bite, nip	}	B = bite
B2 = bite, draws blood/breaks skin		
C1 = chase, ≤2 body lengths*	}	C = chase*
C2 = chase, >2 body lengths*		
D = displace*		
F1 = flee/move away, ≤2 body lengths	}	F = flee/move away
F2 = flee/move away, >2 body lengths		
J1 = joust ≤30s*	}	J = joust/spar/fight*
J2 = joust >30 s*		
M1 = mount/attempted mount ≤30 s	}	M = mount/attempted
M2 = mount/attempted mount >30 s		
P = play (between pups or weaned pups)*		
R = roll/present ventral		
V = vocalize		

b) spatial association
N = mother-pup pair (any distance)
L = association by location only (distance ≤10 m apart, for all except mother-pup pairs)

2) entangling object
L = association by location only (distance <2 m)
E = subject is entangled

Appendix B.--Continued.

3) nothing nearby

O = no behavior or association

* requires a corresponding code on the line of the associated seal

CONTINUE--If the same animal is recorded on another line for any reason (e.g., additional tag or association, behavior at a later time, change of beach position), put the line number you are continuing from here. Lines may be continued only within the same page.

NOTES-- ✓ or 1 if you have handwritten notes on the observation. Put handwritten notes on the back of the census form, labeled by line number.

L = observation is purely incidental--i.e., not on census or patrol

Additional notes:

1. All associations (except with entangling objects) should be in pairs, i.e., between animals on two different lines. If the behavior is active, you should fill in the line numbers, distances, and behavior codes for both animals involved in the association. If the behavior is **N** or **L**, however, you may record the association on only one of the lines, and the computer will fill in the other line.

2. An association should either be all blank or have the **O** behavior only, with no line number or distance, or have a line number, a distance, and some behavior code (other than **O**) all present.

3. On a census it is assumed that molt, disturbance, and behavioral data will be taken. Thus, on a census data sheet, no code in any of the A or B columns means that the seal was alone, whereas on a patrol data sheet, no code may simply mean that no data were taken. It is not necessary to put an **O** code for each unassociated animal on census. The computer will fill this in later.

4. Weather information (except temperature) should be a summary of the entire day up until the end of the census, not merely an instantaneous observation.

5. A separate data sheet should be filled out for each date, observer, data type, and island within an atoll. If no seals are present, you should still fill out the information at the top of the census form and write "No seals" in the data area. If the island itself is not present, indicate this by using "99" for the sector code, leaving the rest of the (first) line blank.

Appendix C.--Summary of census counts and monthly means of Hawaiian monk seals by sex and size at Laysan Island, 1985 (M = male, F = female, and U = sex unknown).

	Adult			Subadult			Juvenile			Pup			Total		
Date	M	F	U	M	F	U	M	F	U	M	F	U	Nonpup	Pup	Combined
3/6	36	14	21	9	15	11	15	13	9	1	0	5	143	6	149
3/9	32	19	20	11	12	12	14	14	7	1	0	6	141	7	148
3/12	29	15	16	8	11	4	12	14	6	1	1	3	115	5	120
3/15	28	12	12	15	8	7	11	11	7	0	1	6	111	7	118
3/18	25	17	0	13	9	10	16	16	2	1	0	9	108	10	118
3/21	34	15	2	12	6	2	16	12	2	1	0	6	101	7	108
3/24	28	15	17	6	4	9	14	13	2	1	0	9	108	10	118
3/27	20	19	7	3	4	5	15	8	3	0	0	9	84	9	93
3/30	32	19	2	10	9	5	17	14	1	2	1	11	109	14	123
Mar.	29.3	16.1	10.8	9.7	8.7	7.2	14.4	12.8	4.3	0.9	0.3	7.1	113.3	8.3	121.7
4/2	32	17	5	13	11	7	20	15	0	1	1	9	120	11	131
4/5	30	17	11	11	10	11	17	15	2	1	2	11	124	14	138
4/8	36	11	8	15	7	4	19	15	1	2	4	6	116	12	128
4/11	28	12	4	10	8	4	13	6	3	4	3	5	88	12	100
4/14	35	17	2	10	10	1	16	12	1	3	2	6	104	11	115
4/17	23	15	5	5	9	4	14	10	2	4	3	8	87	15	102
4/20	26	21	7	6	4	2	8	8	1	2	4	6	83	12	95
4/24	28	18	1	9	7	3	16	9	0	4	4	6	91	14	105
4/26	27	15	0	11	11	3	15	6	0	6	3	9	88	18	106
4/29	17	14	8	4	7	6	11	9	0	3	5	12	76	20	96
Apr.	28.2	15.7	5.1	9.4	8.4	4.5	14.9	10.5	1.0	3.0	3.1	7.8	97.7	13.9	111.6
5/2	22	20	14	8	10	3	7	9	6	4	3	8	99	15	114
5/5	16	21	3	4	10	9	13	10	1	5	3	8	87	16	103

Appendix C.--Continued.

	Adult			Subadult			Juvenile			Pup			Total		
Date	M	F	U	M	F	U	M	F	U	M	F	U	Nonpup	Pup	Combined
5/8	29	25	3	11	10	3	11	10	3	7	8	9	105	24	129
5/11	30	26	4	7	10	5	14	6	1	7	7	6	103	20	123
5/14	29	21	10	4	6	7	14	9	1	8	7	6	101	21	122
5/17	31	24	3	10	20	5	9	8	0	9	8	5	110	22	132
5/20	26	22	4	9	18	5	14	10	0	8	6	5	108	19	127
5/23	26	24	4	7	15	1	9	8	3	7	6	2	97	15	112
5/26	18	20	14	4	8	5	11	5	1	6	7	6	86	19	105
5/29	25	20	1	8	21	1	13	11	1	7	8	5	101	20	121
May	25.2	22.3	6.0	7.2	12.8	4.4	11.5	8.6	1.7	6.8	6.3	6.0	99.7	19.1	118.8
6/1	23	25	2	4	18	3	13	10	2	9	6	5	100	20	120
6/4	20	22	6	7	16	3	7	4	1	9	7	2	86	18	104
6/7	18	11	27	4	2	5	7	5	4	6	7	3	83	16	99
6/10	24	18	2	12	14	5	12	6	0	11	6	1	93	18	111
6/13	25	24	0	8	15	6	15	11	1	11	9	1	105	21	126
6/17	22	16	0	8	13	8	17	9	2	10	8	0	95	18	113
6/19	32	18	3	6	12	4	12	11	0	11	9	0	98	20	118
6/22	35	12	5	10	12	7	7	7	2	12	9	1	97	22	119
6/25	26	16	0	12	18	3	13	9	0	9	11	0	97	20	117
6/28	21	14	0	13	8	6	11	9	1	10	11	0	83	21	104
June	24.6	17.6	4.5	8.4	12.8	5.0	11.4	8.1	1.3	9.8	8.3	1.3	93.7	19.4	113.1
7/1	25	17	2	12	17	7	12	12	2	10	13	0	106	23	129
7/3	33	24	3	11	13	6	16	13	1	8	10	0	120	18	138

Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Nonpup	Pup	Combined
7/7	22	21	1	17	11	6	13	12	1	12	12	0	104	24	128
7/10	23	16	0	12	11	7	16	11	0	7	8	0	96	15	111
7/13	21	18	0	16	14	3	13	12	1	14	11	1	98	26	124
7/16	25	19	0	13	9	7	14	13	1	9	9	1	101	19	120
7/18	21	18	3	14	6	9	15	10	0	9	7	1	96	17	113
7/22	21	20	4	14	5	9	14	14	1	12	7	0	102	19	121
7/24	23	12	3	8	6	11	11	13	5	8	6	2	92	16	108
7/26	19	15	5	11	7	9	13	17	2	9	7	0	98	16	114
7/28	24	8	12	7	9	10	18	9	3	11	10	1	100	22	122
7/31	24	10	14	10	4	10	19	15	6	10	6	0	112	16	128
July	23.4	16.5	3.9	12.1	9.3	7.8	14.5	12.6	1.9	9.9	8.8	0.5	102.1	19.3	121.3
8/3	23	17	8	7	1	9	15	12	6	5	11	0	98	16	114
8/6	26	21	2	10	6	6	16	14	2	12	9	0	103	21	124
8/9	25	11	10	5	5	5	18	14	4	10	10	0	97	20	117
8/13	34	14	3	10	5	4	11	8	3	8	8	1	92	17	109
8/17	26	6	8	6	2	11	12	11	3	6	6	0	86[a]	12	98
8/20	24	15	2	7	6	6	11	10	7	9	7	0	88	16	104
8/24	26	9	5	9	6	2	12	12	1	7	7	0	82	14	96
8/27	35	10	2	8	2	3	12	14	4	6	8	0	90	14	104
8/30	48	5	2	12	0	2	13	14	3	5	8	0	99	13	112
Aug.	29.7	12.0	4.7	8.2	3.7	5.3	13.3	12.1	3.7	7.6	8.2	0.1	92.8[a]	15.9	108.7
9/2	48	13	3	10	2	2	13	7	2	6	9	0	100	15	115

Appendix C.--Continued.

	Adult			Subadult			Juvenile			Pup			Total		
Date	M	F	U	M	F	U	M	F	U	M	F	U	Nonpup	Pup	Combined
9/5	60	9	1	9	1	0	12	10	4	9	6	0	106	15	121
9/9	58	6	8	4	1	3	13	5	2	6	9	0	100	15	115
9/12	58	7	0	4	2	1	7	11	1	8	7	0	91	15	106
9/16	66	8	1	7	3	4	10	8	4	6	9	1	111	16	127
9/19	63	8	4	5	2	2	13	5	4	4	10	0	106	14	120
9/24	64	6	3	6	3	2	9	5	4	6	4	2	102	12	114
9/27	63	3	9	8	1	1	13	6	3	6	6	2	107	14	121
9/30	58	10	3	5	2	4	13	14	4	8	9	1	113	18	131
Sept.	59.8	7.8	3.6	6.4	1.9	2.1	11.4	7.9	3.1	6.6	7.7	0.7	104.0	14.9	118.9
10/3	64	10	2	3	2	5	14	9	2	5	6	0	111	11	122
10/5	62	5	5	5	3	1	10	11	2	5	8	0	104	13	117
10/8	57	9	7	7	2	4	11	11	2	8	9	0	110	17	127
10/11	54	12	3	3	3	1	8	9	1	7	9	0	94	16	110
10/15	67	14	0	6	5	1	11	12	1	10	9	0	117	19	136
10/18	54	10	5	8	4	4	15	12	6	7	11	0	118	18	136
10/21	54	13	1	7	7	2	15	12	2	8	7	0	113	15	128
10/24	45	10	3	3	1	4	13	14	2	8	7	0	95	15	110
10/28	43	8	0	5	5	4	13	9	4	8	7	0	91	15	106
Oct.	55.6	10.1	2.9	5.2	3.6	2.9	12.2	11.0	2.4	7.3	8.1	0	105.9	15.4	121.3
11/1	44	11	0	6	7	1	19	11	4	6	8	0	103	14	117
11/4	41	8	0	8	2	0	11	11	0	6	8	0	81	14	95
11/7	42	11	0	13	1	2	13	11	3	6	7	0	96	13	109
11/11	47	8	2	8	5	3	15	9	0	4	4	0	97	8	105

Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Nonpup	Pup	Combined
11/14	40	8	0	12	5	3	14	13	3	6	8	0	98	14	112
11/20	45	12	0	11	9	0	17	17	6	9	11	0	117	20	137
11/23	42	21	0	9	7	4	20	17	0	12	12	0	120	24	144
11/26	58	27	0	14	9	3	18	16	2	8	11	0	147	19	166
Nov.	44.9	13.3	0.3	10.1	5.6	2.0	15.9	13.1	2.3	7.1	8.6	0	107.7	15.8	123.1

[a]Total includes some seals that were not placed in any size class.

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